RESEARCH HIGHLIGHTS

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TECHNOLOGY DISSEMINATION: TRIGGERING INNOVATION ADOPTION IN CANADA'S HOME CONSTRUCTION INDUSTRY

Introduction

There are many proven innovative technologies available to the residential construction industry, but even with modern and aggressive information dissemination techniques, it still requires 15 to 25 years for a new technology to be widely adopted by the industry. This means that, on average, the Canadian residential construction industry makes use of only some 50 per cent of the available quality-enhancing or cost-cutting innovations at any given time. And half of this advantage happens only during the last five to six years of an innovation's introductory period. The unique structural nature of the industry and limited resources pose inherent barriers to pursuing innovation adoption.

The delay in uptake can limit advances in housing construction quality, cost efficiencies and environmental benefits. A key question, therefore, is how to encourage builders and subcontractors to more rapidly adopt innovative approaches, using proven technologies, tools and practices.

The proposed strategy and work plan for this project differ from the three traditional means of disseminating information: training, demonstration and research networks or construction centers. Training often focuses on individual technologies and usually ignores issues of costing, marketing and interpersonal and inter-trade relationships. Demonstration housing projects and construction centers tend to highlight entire systems and are frequently used primarily as marketing tools. Such projects or centres often address non-quantifiable issues, such as healthy housing or energy conservation.

An alternative approach, proposed and tested in this study, involves the simultaneous introduction of numerous, cost-effective innovations which a builder and subcontractors first apply to one or two houses. It is anticipated that some innovations will prove a success, some will generate a neutral response, and some will be dropped. Once the builder and trades see the benefits of certain innovations, it is thought that they will continue to use them, forcing competitors to adopt these or other innovations in order to remain competitive.

The approach focuses on results rather than processes and is considered more aggressive than one of simply encouraging innovation adoption. The objective is to help ease and multiply pro-innovation decisions. In this way it is similar to adoption programs found in major manufacturing spheres such as the auto or aircraft industry.

For these reasons, the approach is referred to as "forced" innovation adoption.

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Forced innovation adoption

An abundance of cost-effective innovations exist from which industry can pick and choose. This project is not about generating innovation. Instead, it focuses on adopting products and processes readily available in the marketplace but which have yet to be used by various companies and widely accepted.

For example, optimum value engineering (OVE) is a concept that has been available, with detailed practice guidelines, for decades. It has been used successfully by some firms, but its use has been so limited it can be considered innovative to many firms or even in certain geographic markets.

The proposed innovation adoption approach is profit-oriented, focusing on innovations that do not require additional effort or cost in being sold to consumers or which would otherwise entail a mark-up cost. Although lifestyle innovations, such as energy efficiency, green building or healthy housing, can be cost-effective on a long-term or societal basis, they often represent added buyer cost and require additional sales effort. These innovations were intentionally not part of this study.

The choices at hand are not necessarily big, splashy ones or product solutions. "Tricks of the trade" are recognized as having significant potential in contributing to overall construction efficiency and lower costs, and project management innovations can be chosen. For example, the report notes that a builders' survey suggests most firms can cut between 23 to 28 days from a typical construction cycle by managing the process differently and that any builder should be able to reduce project time by at least 15 days.

Financial benefits arising from use of these innovations may not necessarily be shared with consumers. In a slow market, a builder may elect to lower prices to retain or gain market share. In a hot market, any savings may be kept or used to increase the quality or perceived value of the homes as a means of differentiating from the competition.

Innovation barriers and accelerators

Numerous concerns and impediments to innovation were identified as part of an information search involving a literature review and interviews. Among the main impediments were size of company (smaller ones lack the resources to invest in an innovation program), lack of an in-house knowledge base necessary to evaluate technologies and processes, and limited skills to take advantage of unfamiliar technologies. Multi-trade innovation is hindered by the lack of inter-trade communication, builders are concerned about liability, and tight scheduling in a highly competitive industry does not permit much room for builders and subcontractors to consider and try innovative approaches. These are just a few of the barriers noted.

The forced innovation adoption process used in this project is designed to overcome these impediments. While the rate of innovation adoption in the housing construction industry is quite low, the information search revealed a number of factors that can help to accelerate adoption:

- entrepreneurial – willing to take risks
- profit-linked – visible profit line allows innovation to be tested and evaluated while limiting the risk to as few as one or two houses
- competitive industry – innovation can be quickly rewarded
- industry diversity – innovation can be introduced without affecting others or requiring their consent
- repetitive units – accepted innovations can be readily applied to other projects
- cross-project performance – adoption by larger contractors can influence adoption by other contractors
- buyer indifference – innovations that are not visible to consumers can be introduced without affecting the marketability of a home.

Methodology for testing forced adoption

The project consultant served as an "innovation champion", whose role is to promote and act as a coach in encouraging a builder and trades people to use and adopt innovative techniques. The innovation champion is instrumental in investigating and evaluating options and working with a builder to introduce selected options to subcontractors.

For this project, the consultant first gathered considerable information on an extensive array of innovative techniques, materials and strategies. After a preliminary review, some 228 innovations were selected for further exploration. These included 96 options of an administrative nature. All options had to be essentially cost neutral or result in a savings, they had to be invisible to consumers with no or limited negative buyer impact, and they had to be code acceptable. Further information was gathered to confirm initial findings and prepare a more comprehensive information package for subsequent analysis and presentation to a home builder.

The following criteria were used in selecting a builder in British Columbia to test the forced innovation adoption process:

- The builder can benefit from investing in a more innovative construction approach and was willing to provide resources to manage and invest in the proposed work.
- The builder is aware of the value of innovations and is interested in a stronger competitive advantage.
- The builder has a stable work force of trades people, which allows for a cooperative work environment and a high level of communication and trust.
- The trades work for other residential builders, which ideally will result in more widespread innovation use.

The builder chose 11 options to test from a list of 38 selected by the innovation champion.

Figure 1. 38 potential cost-saving strategies

Foundation systems	wooden post and beam replacing concrete basement; Anchormate bolt holders; Q-Liner pier uplift reduction system and pier slip collar; self-consolidating concrete; stemwall foundations; Bigfoot pier pads; footing tube; FastFoot foundation and FastPad pier foundation; mudsill strap anchors
Framing	carpenter's steel stud; OVE strategies; job-site framing tables
Services	wooden plenums; plenum enclosures and bulkheads; speed wiring; extra kitchen panel
Environmental barriers	Vapour-Form joist space sealer; 2x4 exterior wall with exterior insulation
Finishing	NoCoat pre-finished drywall corners and trim beads; pre-finished attic hatch; drywall rescheduling - cycle time reduction; Canadian Gypsum drywall panel compositions; drywall clips; low-temperature paint
Inspections and warranty	consumer inspection/orientation visit; house warming gift kit; homeowner manual; service vouchers and warranty payouts; warranty service notices; computerized warranty tracking; periodic notices and consumer information; integrated drafting/estimating
Tools	the CLEAT; Centre-Point tapes; Ultra-Square; The Joister; EZ-Shim
Project management	cycle time reduction

The builder staggered construction starts for two identical units, which allowed the project team to review their existing practices. This led to a number of framing changes, not only for the second unit but also to the builder's general framing guidelines for all other units.

Before construction work commenced, the local municipal building inspectors were introduced to the foundation system that would be used, in order to familiarize them with the system and to smooth the way for its subsequent use in other units. The impending winter season, however, resulted in the foundations being poured before the subcontractors could be introduced to the project. This affected the time available to fully engage them as part of the project team and create a genuine sense of ownership and acceptance of the proposed changes.

The demonstration project concluded with interviews of the primary site superintendent and the contractor's team leader.

Innovations used and results

From the cost-saving strategies provided by the innovation champion, the builder pursued 11 options with the following results:

1. *Integrated drafting/estimating* – This enables a builder to order lumber more precisely and avoid relocating lumber from one site to the next or having excessive wasteage. While this option was not used for the demonstration unit, the contractor's design department began experimenting with a drafting program as part of this project's exploration into innovation, with the stated goal of identifying and adopting an integrated system.
2. *Standardized drawings* – Some were produced, with construction details codified. Ongoing standardization is proceeding.
3. *Site management and trade partnering* – The builder used the project to foster a supportive team approach and inter-trade relations. Initially, there was indifference, even some hostility towards the project, but this notably changed as the trades discussed the project more fully with the site superintendent. There was marked improvement in inter-trade communication, and one subcontractor insisted on including some of the innovations in his own house which the builder was building for him, even though the innovations had yet to be fully vetted as standard practices.
4. *FastFoot and FastPad* – This system in itself did not prove time- or cost-effective for this particular job site, but this does not preclude it from being advantageous for other projects, particularly where footing production practices are less advanced. However, the builder did adapt some of the system's techniques, which improved the system already in use.
5. *Insulated concrete forms (ICF)* – This technology is actually still in the investigative stage. However, as part of this project's focus on innovation, the builder began exploring its potential use for either the basement or the whole house with ICF representatives and the concrete industry. Investigations were still underway at the conclusion of this project.
6. *Item specific lumber ordering* – The builder engaged his lumber supplier to develop itemized material take-offs and estimating as a means of reducing costs. Work continued beyond the project to develop an advanced ordering system in concert with the drafting/estimating software initiative.
7. *Optimum value engineering (OVE) framing details* – A number of framing details were introduced for evaluation. Corner details and top plate blocking were changed to eliminate the backing normally included to support drywall with the intention of replacing it with drywall clips. OVE techniques progressed from the exploratory stage to codification as part of the company's standard detailing. Further refinement of framing practices are expected.
8. *Insulation techniques and responsibilities* – At the subcontractor's suggestion, the slope of the vaulted ceilings was reduced to 4.5:12 in order to use blown insulation rather than insulation batts. Responsibility for installing rigid insulation above the garage was reassigned to the insulator, freeing up the general contractor's labour for other tasks. These changes have been adopted as standard practice by the builder.
9. *Electrical modifications* – The meter and the panel were separated, with the panel being located towards the centre of the house and closer to the kitchen, from which wires were run in a less expensive star configuration. A modified speed wiring approach was used, which replaced one journeyman electrician working five days with up to three electricians of varying skill levels working just two days. These changes have been adopted as standard practice for the builder, and a previously reticent subcontractor is now contributing to the ongoing design re-evaluation process and continual innovation upgrade.

10. *Drywall clips* – Drywall clips were used to provide the requisite support at some inside corners and at the ceiling-wall junction, in place of lumber backing. The clips not only saved money, they circumvented the need for blocking in a number of corner locations that are heavy servicing areas.
11. *NoCoat corner bead* – Following a demonstration of this product in some test areas, it was not accepted for further use as the product normally used was almost the same in quality. The thick bead from the test product also made finishing corner joints more difficult and time consuming.

Conclusions

Given the limited application of the process, the project did not conclusively prove that widespread innovation adoption will occur in the home building industry as a result of loading builders and trades with information about innovative options and championing their adoption.

However, the project did result in positive findings for the most part. The various technologies or innovations explored were consistent with general construction practices and easily integrated with other conventional products, processes and systems. During the course of gathering and evaluating information on the wide variety of innovation choices, a number of points became clear:

1. There is no shortage of tested innovations from which to choose.
2. There is a broad range of innovations to meet the needs of all sizes and types of residential construction companies.
3. Most innovations do not require any unique skills to implement.
4. Innovations with the greatest payback potential i) tend to require fundamental changes in thinking and operations, and ii) are inexpensive to introduce.

The demonstration project proved that no exceptional training was required. No managerial or site issues arose, and the demonstration home was successfully built with a minimum of problems or required site adjustments. With a couple of exceptions, the innovations were generally less expensive or comparable to traditional methods while producing superior solutions.

What little manipulation of the payment schedule that was required was well within the contractor's capabilities. It was thought that few, if any, accounting or fee adjustment problems would be encountered by others attempting similar endeavours.

Although the builder was committed to innovation from the outset, the research helped to strengthen that commitment by providing factual information, not just theory. The project appears to have created a pro-innovation environment on the part of the subcontractors as well, with participants indicating a strong willingness to continually pursue innovation adoption.

For similar undertakings, though, more time should be allowed to introduce subcontractors to the process. Care should also be taken to ensure that proposed innovations are not seen as a challenge to people's expertise and workmanship. When invited and properly integrated into the process, subcontractors not only adopt suggested innovations, they contribute by suggesting their own innovations. They should be involved early on in the process and participate in selecting the model home to be used for testing and in evaluating the technology options that might be employed. Greater attention should also be given to the "soft" technologies, such as cycle time reduction and managerial changes, as these have historically shown the best rate of return.

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Research Report: *Technology Dissemination: Triggering Innovation Adoption in Canada's Home Construction Industry*, 2001

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Housing Research at CMHC

Under Part IX of the *National Housing Act*, the Government of Canada provides funds to CMHC to conduct research into the social, economic and technical aspects of housing and related fields, and to undertake the publishing and distribution of the results of this research.

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